YAHOO! MAIL Classic

RE: Lower Silver Creek Documents Wednesday, March 12, 2008 7:16 AM

From: "Marshall, Bruce" <Bruce.Marshall@tetratech.com>
To: "Jessie Goldfarb" [redacted]
Cc: hernandez.kathryn@epa.gov
Innovative_Assessment_Analytical_Results.pdf (1073KB)

Jessie

Here's the text for the 2002 report. Figures, appendices, etc. are too large to email. Copying them right now.

Bruce

From: Jessie Goldfarb [redacted]
Sent: Tuesday, March 11, 2008 11:14 PM
To: Marshall, Bruce
Cc: Craig, John ; Longwell, Daryl ; EPAKathrynHernandez@tmo.blackberry.net
Subject: RE: Lower Silver Creek Documents

Thanks so much everyone.

Bruce--Thanks for e-mailing the documents in the AM. I'll be home all day in Boulder . Just give me a call at [redacted] before you deliver the copies so I know when to expect you.

Many thanks,
Jessie

" Marshall, Bruce " <Bruce.Marshall@tetratech.com> wrote:

> Yes. We'll email first.
>
> Bruce
>
> -----Original Message-----
> From: Kathryn Hernandez [mailto: EPAKathrynHernandez@tmo.blackberry.net]
> Sent: Tuesday, March 11, 2008 8:41 PM
> To: Marshall, Bruce ; hernandez.kathryn@epa.gov; Jesse Goldfarb
> Cc: Craig, John ; Longwell, Daryl
> Subject: Re: Lower Silver Creek Documents
>
> Can you email her the documents without maps first thing and then get her the documents as soon as they are copied?

Kathy
Sent from my BlackBerry wireless handheld.

-----Original Message-----
From: " Marshall, Bruce "

Date: Tue, 11 Mar 2008 18:17:58
To:hernandez.kathryn@epa.gov,"Jesse Goldfarb"
Cc:" Craig, John " ," Longwell, Daryl "
Subject: RE: Lower Silver Creek Documents

Kathy - It will take a little while to get things copied in the morning.

Jessie - how late will you be in Boulder in the morning?

Bruce Marshall

-----Original Message-----
From: Kathryn Hernandez [mailto: EPAKathrynHernandez@tmo.blackberry.net]
Sent: Tuesday, March 11, 2008 6:36 PM
To: Longwell, Daryl ; Marshall, Bruce
Cc: Jesse Goldfarb; Craig, John
Subject: Fw: Lower Silver Creek Documents
Importance: High

Hi Guys;

I am in Libby, so I was hoping you could get copies of the Listing Package for Lower Silver Creek and the 2002 State Assessment to Jessie Goldfarb our site attorney. Her address is below. Please let me know if there is any problem getting this to her early tomorrow (7203527497)

Thanks,

Kathy
Sent from my BlackBerry wireless handheld.

-----Original Message-----
From: Jessie Goldfarb

Date: Tue, 11 Mar 2008 17:25:42
To:hernandez.kathryn@epa.gov
Subject: Lower Silver Creek Documents

Thanks again for arranging to have the UDEQ Assessment figures and the Listing Package delivered to me tomorrow ASAP.

[redacted]. The easiest way to get to me is: [redacted]

Be a better friend, newshound, and know-it-all with Yahoo! Mobile. Try it now.

INNOVATIVE ASSESSMENT ANALYTICAL RESULTS REPORT

Lower Silver Creek

Summit County, Utah

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
Division of Environmental Response and Remediation
Prepared by : Ann M. Tillia

1.0 INTRODUCTION

Under authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended, and in accordance with applicable provisions of National Oil and Hazardous Substance Pollution Contingency Plan (NCP), the Utah Department of Environmental Quality, Division of Environmental Response and Remediation (DERR) is conducting an Innovative Assessment (IA) of the **Lower Silver Creek (LSC Site)** east of Park City, Summit County, Utah. These activities are conducted under a cooperative agreement with the United States Environmental Protection Agency, Region VIII (EPA). A Work Plan was approved by UDEQ/DERR prior to the field activities[1].

The scope of this IA includes an on-site reconnaissance, identification and evaluation of potential exposure routes, the taking of photographs, the screening of 213 x-ray fluorescence (XRF) soil sample locations, and the following samples that were analyzed in the Utah State Division of Epidemiology and Laboratory Services: 21 soil samples, 24 sediment samples, and 27 surface water samples. The XRF screening of soil sample locations and the collection of samples for laboratory analysis is necessary to determine if hazardous materials are present on-site in concentrations that may pose a threat to human health or the environment. Metals of concern include, but are not limited to: zinc, lead, mercury, arsenic, antimony, cadmium, chromium, and copper. All laboratory samples have been analyzed for total metals. The laboratory Analytical Results Report is provided in Appendix D and the Pre-CERCLIS Screening Assessment Checklist/Decision Form is provided in Appendix F.

2.0 BACKGROUND INFORMATION

2.1 Site Location and Description

The LSC Site extends over 12 miles along the banks of Silver Creek from State Route 248 north of Richardson Flat, two miles east of Park City, downstream to the confluence with the Weber River in Wanship (Figure 1). The site has been subdivided into southern and northern portions, due to the site conditions and topography. The northern portion of the site, from Atkinson to Wanship, consists of a narrow corridor located between the lanes of Interstate 80 (I-80), which includes the Rail Tail, Silver Creek and the associated riparian habitat (Figure 2). The southern portion of the LSC Site, approximately 4.4 miles between Atkinson and State Route 248, is as much as 2,500 feet across, east to west (Figure 3).

The southern portion of the LSC Site upstream from Atkinson is quickly being surrounded by residential and commercial expansion. Several businesses, including the Summit County Sheriff's Office, Home Depot, and a Rolls-Royce Office, are located on the upland west of the southern portion of the LSC Site. Pivotal Promontory, LLC has begun construction of their private club and second-home community project, which parallels the southern portion of the LSC Site area to the east.

The headwaters of Silver Creek are located upgradient of Park City. Silver Creek is the primary drainage within the watershed downstream to the Weber River confluence in Wanship, Utah. The Weber River is a Class 4 (agricultural), 3A (cold water fishery), 2B (contact recreation), 1C (source of drinking water). Silver Creek is Class 3A, 1C, and 4 stream[1]. Within the LSC site, Silver Creek has water rights beneficial uses for domestic water (Water Right 35-10477, 35-8820, 35-8829, and 35-5706), stock, irrigation, and recreation[1].

There are four municipal drinking water wells within the site area. In the northern portion of the site area near Wanship, Mutual Water Company Wells No. 2 (east) and Well No. 1 (west) supplies water to a combined total of 500 persons. In the southern portion of the site area, Mountain Regional SSD supplies water to 450 persons with water from Wells No. 3 and No. 10. In 1999 the initial pump test on Well No. 3 the water well log shows the total depth of the well is 320 feet below ground surface (bgs), the draw down was 113 feet bgs in 72 hours, the static water level was 16 feet bgs, and the well produced 130 gallons per minute (gpm)[2]. The 1998 water well log for Well No. 10 shows the total depth of the well is 415 feet bgs, the draw down was 225 feet bgs in 72 hours, the water level flowed at the ground surface, and the well produced 400 gpm[2].

Silver Creek receives water from precipitation (snowmelt), groundwater, springs, and mine tunnels (Spiro Tunnel) within its basin[3]. Mining in the area required dewatering at depth and resulted in the construction of the Judge Tunnel near the headwaters of Silver Creek in the late 1880's. The flow from the Judge Tunnel averaged 850 gallons per minute for the years 1968 through 1991[1]. A 1986 USGS report indicates Silver Creek obtains its base flow from springs in consolidated rock, and the primarily contributor is Dority Spring located north of Prospector Square flowing at a rate of 4,315 ac/ft/yr[3]. In addition, the 1986 USGS study found Silver Creek gains water at a rate of 5,600 ac/ft/yr from unconsolidated valley fill between a point up-gradient of Richardson Flat and a point downstream near Atkinson[3].

Another study by the USGS in 1998 subdivided the Silver Creek basin with the Upper Silver Creek sub-basin extending from the headwaters to the downstream side of Prospector Square[1]. The Upper Silver Creek USGS sub-basin covers 6,500 acres. The Lower Silver Creek USGS sub-basin extends from the Upper Silver Creek sub-basin downstream 2.5 miles north of Atkinson and consists of 13,700 acres. The groundwater recharge from precipitation constitutes 50 percent of the recharge for the Lower Silver Creek sub-basin. The total surface water budget for the Lower Silver Creek sub-basin is 14,000 acre-feet (ac/ft/yr), which includes 6,000 ac/ft from the Upper Silver Creek sub-basin, 3,000 ac/ft from precipitation, and 4,000 ac/ft from groundwater to Silver Creek[1].

Surface water enters the south end of the site near State Route 248 in a ditch (Pace-Homer Ditch) and flows north crossing under the Rail Trail to the east and past the Homer Spring. Downstream from Homer Spring the ditch turns west water flows through a culvert under the Rail Trail near the sample location LSC-SS-65 that is north of the section that was not sampled due to a lack of a signed Grant of Access form prior to the sampling. Silver Creek crosses under the Rail Trail just south of LSC-SS-67 and meanders north of generally gaining surface water as it flows downstream (Appendix E).

The geographic coordinates for the southern point of the site are 40° 40' 58.31" North Latitude and 111° 27' 22.44" West Longitude located in the southeast quarter of Section 35, Township 1 South, Range 4 East, Salt Lake Base and Meridian. The site extends north through parts of Sections 26, 27, 23, 22, 14, 15, 10, 11, 2, Township 1 South, Range 4 East, Sections 35, 26, 25, 24, Township 1 North, Range 4 East, and Sections 19, 20, and 17, Township 1 North, Range 5 East.

2.2 Site History and Previous Work

Mining in the Park City area began around 1869 and the first shipment of ore, 40 tons, was sent out by rail in July 1870[1]. The total production of ore from the mining area for the years 1875 to 1967 was nearly 16 million tons. The highest quantity of ore mined was lead followed by zinc, gold, silver, and copper, respectfully[1]. There have been as many as 10 mills operating along the banks of Silver Creek throughout the history of mining near Park City[1]. Historically, the LSC Site historically received mine tailings washed down Silver Creek from the upper Silver Creek Watershed near Park City, Summit County, Utah. The majority of the milling companies along Silver Creek were located upstream from the LSC Site, which included the Grasselli, Broadwater, and E.J. Beggs mills, located in the Prospector Square area of Park City[1].

Historically, the primary mill operating within the LSC Site was the Big Four (Figure 1). The footings of the foundation of the Big Four Mill are located next to the Pace Ranch building that is adjacent to the road between the Summit County Sheriff's facility and the Promontory development project (Promontory Road) shown in Photo 3-17 (Appendix B). In the early 1900's four geologists from the east coast established the Big Four Exploration Company (Big Four) near Atkinson, seven miles northeast of Park City. In 1916, the Big Four was said to be the third largest mill in the state, consisting of a two-month stockpile of 50,000 tons of ore and the capacity to process 1,800 tons of ore tailings daily. The tailings field at the Big Four Mill site was 3.5 miles by 400 to 1200 feet wide and two inches to eight feet deep. The settling pond for the Big Four Mill held 200,000 gallons and was 100 feet in diameter by four feet deep[1]. An unnamed spring located south of the historical mill site was used in the processing of ore (Figure 3)[5]. The Big Four employed over 100 men and provided a boarding house and school for their families[1]. The remains of the school are found on the LSC Site as shown in Photo 3-11, Appendix B.

In October 1916, the Big Four reported processing 700 tons of ore daily with a recovery of 60 percent of the zinc, 40 percent of the lead and 35 percent of the gold and silver from the tailings. The Big Four Mill operation earnings were rated at $1,400 per day and $504,000 per year[1]. By 1918, Big Four had over-sold company stock and the mill was sold in bankruptcy proceedings for $35,500[1]. After its' closure, the mill site was still considered to be worth milling[1]. In the mid 1900's additional mill related activities on the LSC Site included removing mine tailings off-site for processing[4,5,6]. The creation of mounds and berms on site may have been part of the preparations to remove tailing from the site for processing. In the 1940's, Silver Creek reportedly flowed milky-white as a result of tailings in the area (see Photos 3-1 and 3-4)[4].

In the 1860's the Union Pacific Rail Road purchased land from the Atkinson family and named the site the Atkinson Station[1]. In the early years, the railroad transported cattle from the Atkinson stockyards, dairy products, and pioneers from Atkinson Station north to Coalville or west to Salt Lake City[1]. Today, Atkinson is located 1.3 miles east of Silver Creek Junction (intersection of I 80 and US 40), consists of a small cattle/dairy ranch owned by the Pace family, one of the original families to settle at Atkinson. The Pace Ranch is located along the banks of Silver Creek within the riparian wetland meadow. The Pace family historically used the water provided by a nearby springs for their culinary needs[5]. Water from Silver Creek has historically been used for stock watering, irrigation, and mining/milling purposes. Property upstream and south of the Pace Ranch (Atkinson) includes parcels owned by the Gillmor family that is irrigated by Silver Creek and used for grazing cattle.

The Union Pacific Rail Road was converted to a Rail Trail in 1992 and 1993[7]. The Rail Trail begins in Park City and extends through the length of the LSC site to Wanship and beyond. Part of the construction of the Rail Trail was made possible with topsoil from the former town of Keetley, which is now the site of the Jordanelle Reservoir[1]. The topsoil was placed on the top and sides of the trail upgradient of Keetley Junction (southwest of the LSC Site). The Rail Trail is used extensively as a non-motorized pathway for recreational purposes including hiking, bicycling, observing wildlife, and access to fishing Silver Creek north of Atkinson. The Rail Trail is overseen by the Utah Division of Parks and Recreation, and is part of the Historical Union Pacific Rail Trial State Park. The Rail Trail was not extensively sampled within this study and may warrant further sampling.

The UDEQ Division of Water Quality (DWQ) has monitored Silver Creek for the last 10 years and has listed Silver Creek watershed on the State of Utah's 303(d) list as impaired by zinc and cadmium. The DWQ is currently conducting a Total Maximum Daily Load (TMDL) water quality study of the Silver Creek watershed in coordination with the Upper Silver Creek Stakeholder Group. A draft of the TMDL report is expected in the summer of 2002. Eight of the ten monitoring sites identified in the TMDL study lie within the LSC Site area (the other two are at Park City and Prospector Square). Thus far, the TMDL study has detected higher concentrations of dissolved cadmium and zinc in Silver Creek in the spring than later in the year, which is attributed to mountain runoff from the winter's snow season[1]. The DWQ collected flow measurements from Silver Creek in conjunction with sampling activities for this IA and the data is provided in Appendix E.

The CERCLIS-listed sites upstream, respectively, of the LSC Site are Richardson Flat (UTD980952840), Silver Creek Tailings (UTD 9809951404), Silver Maple Claims (UTD 980951396), Old Park City Dump (UTD 988078606), Marsac Mills (UT00018945054), and Empire Canyon (UT0002005981). In addition, Innovative Assessments, which are a pre-CERCLIS screening report, have been completed on several upstream mining-related sites: Ontario Mine, Ontario Mill, Silver King Mine and Mill, Treasure Hollow, California/Comstock Mill sites.

2.3 Waste Characteristics

Mine tailings generally cover the entire southern portion of the LSC Site. Tailings are readily apparent in the non-vegetated, gray colored sandy and/or gravelly mounds and low ridges (or berms) within the riparian habitat along Silver Creek particularly in the southern portion of the LSC Site (Appendix B, Log of Photographs). Elongated berms trend north-south and are found throughout the entire southern portion of the LSC Site. Berms located along some reaches of Silver Creek and the Pace-Homer Ditch may have been created by maintenance and dredging of the waterways.

Vegetation in the southern portion of the LSC Site primarily consists of two types of grasses and one tree. A type of sedge grass is found in the drier areas surrounding the non-vegetated mounds and berms[8]. The hardy sedge (referred to as "wire grass" by the property owners) is not palatable to the livestock (primarily cattle) and grows to a height of 1 or 2 feet. The preferred grass eaten by the cattle is located in the wetter areas (in drainages; in the hummocky wet areas) and on the uplands. A sparse amount of sagebrush grows in the upland south of the pig shed, between the Rail Trail and Silver Creek (Figure 3). The identification of the plant species within the LSC Site was not part of the Work Plan. However, the Field Activities Report and Tabulated Summary provides additional information specific to the sample locations.

One of the parcels not sampled, due to the a lack of an access agreement prior to the time of sampling, is located north of the Pivotal Promontory access road and west of the historical Big Four Mill site (Photo 3-13, Appendix B). The aforementioned parcel is reportedly part of a wetland mitigation agreement to build a road across the wetlands (Promontory Road) that included the planting of several trees that died apparently due to poor soil conditions[5]. A frog species was also introduced to the mitigated wetland and apparently did not survive[5].

The northern portion of the LSC Site area is generally a well-vegetated riparian habitat. A beaver dam was observed upstream from Alexander Canyon. Fish were observed in Silver Creek at a few sample locations downstream of the remains of the historical school house (not its original location) (Appendix A). Various bird species were observed along the banks of Silver Creek. Mine tailings were not observed more than one mile north and downstream of Atkinson during field sampling activities.

3.0 FIELD ACTIVITIES

3.1 Sampling Work Plan

The Scope of Work completed in the field activities was based on the Work Plan submitted and approved by UDEQ/DERR[1]. The Work Plan included the screening of approximately 200 soil sample locations with an XRF instrument, the collection of soil samples (10 percent of the XRF screening locations), and the collection of 25 surface water samples collected concurrently with 25 sediment samples from Silver Creek. In addition, the Work Plan included the collection of three surface water and seven soil/sediment opportunity samples. Other planned activities within the scope of the Work Plan included the documentation of each sample location with a Global Positioning System (GPS). The samples collected for laboratory analysis of total metal concentration were sent to the State of Utah Division of Epidemiology and Laboratory Services, Salt Lake City, Utah.

Sampling proceeded in accordance to methods outlined in the DERR CERCLA Quality Assurance Project Plan (QAPP) for Environmental Data Operations of May, 1999. All sample containers were obtained from State Laboratory Services. The surface water sample containers were supplied with a nitric acid preservative. All samples were preserved with ice to four degrees Celsius and retained under chain-of-custody as prescribed by the QAPP. A map of the sampling sites (Figure 2 and 3), field notes (Appendix A), and photographs (Appendix B) documenting the sampling event are provided within this report. In addition, the chain-of-custody and data validation documentation is provided in Appendix D of this report.

Soil samples were collected with a stainless steel spoon at or within 6 inches of the ground surface, and placed directly in an eight-ounce glass sample jar. An adequate supply of disposable and previously decontaminated sampling equipment was supplied at the site to avoid the need for field decontamination. All disposable sampling equipment was removed from the site and disposed of as non-hazardous. Excess soil and sediment from the samples was returned to its original location.

The 25 surface water samples and sediment samples were collected concurrently from Silver Creek at approximately 0.5-mile intervals within a 7.5-hour period. Flow measurements were taken and water data was collected concurrently with the sampling of Silver Creek. During a two-week period, the location of 213 soil samples analyzed with an XRF were selected in a random and biased fashion. All soil sampling was conducted in non-vegetated and vegetated areas alternating sample locations between the lower elevation riparian areas and the higher ground (uplands) generally west of the Rail Trail. The Rail Trail was not extensively sampled within this study and may warrant further sampling (Photo 3-5, XRF 79 in Table 1).

Access to the various properties was granted prior to sampling. Landowners signed a DERR Grant of Access to Property form or granted verbal access and were apprised of their right to obtain spilt-samples (Appendix C). The option to collect a split samples was exercised by one property owner, Park City Municipal Corporation. A Health and Safety briefing was held for the DERR personnel on the day of sampling prior to sampling the site. There were no safety matters that became a problem during the sampling event.

3.2 Deviations from the Work Plan

Deviations from the Work Plan are as follows:

- All samples were analyzed for total metals. The option to not collect samples for analysis of dissolved metal as specified in the Work Plan was taken, based on the suspended sediment load of the surface water observed in the field.

- A field screening of the sediment samples with the XRF instrument was not completed due of the time constraints in the field and availability of data, which is provided by the laboratory analysis of the samples.

- Of the 25 surface water samples designated in the Work Plan to be collected from Silver Creek, three samples (LSC-SW- 04, LSC-SW- 05, and LSC-SW-06) were not collected due to a lack of access to the property prior to the time of sampling (11/02/01). Sample LSC-

SW-06 was reassigned as an opportunity sample that was collected from the unnamed spring located south of the historical Big Four Mill.

- Three of the 25 sediment samples (LSC-SD-34, LSC-SD-35, and LSC, SD-36) designated to be collected concurrently with the surface water samples (LSC-SW- 04, LSC-SW- 05, and LSC-SW-06), were not collected because access was not obtained prior to sampling.

- Surface water sample LSC-SW-26 was designated a field duplicate for Quality Assurance/Quality Control purposes to be collected concurrently with sample LSC-SW-04, however, it was not collected because access to the property was not obtained prior to sampling activities. The surface water sample LSC-SW-26 was not re-assigned to another sample location.

- Sample LSC-SD-77 was designated the opportunity sediment sample to be collected concurrently with LSC-SW-29 from the Alexander Canyon Creek at the confluence with Silver Creek was damaged (the glass sampling jar broke) in transport between the field and the DERR office. The sediment sample LSC-SD-77 was dried in the office and analyzed with the XRF (the analysis is provided in Table 1.0, XRF 292 and 293).

3.3 Sampling Activities

The sampling and field observations of the LSC Site occurred on eight days in November 2001. A Field Activity Report and Tabulated Summary, which includes water data collected on November 2, is provided in Appendix A of this report. In addition, water flow data was collected during the November 2 field activities and is provided in Table 6.

On November 2, 2001, 22 surface water samples were collected concurrently with 22 sediment samples from Silver Creek (Figure 2 and 3). Additional sampling included the collection of field duplicate surface water sample LSC-SW-27 collected concurrently with sample LSC-SW-19, three surface water/sediment opportunity samples (LSC-SW-28/SD-76, LSC-SW-29/SD-77, and LSC-SW-30/SD-79), and one opportunity soil sample (LSC-SS-78).

Field activities on November 6, 8, 9, 13,14, 15, and 19, 2001 were conducted in the southern portion of the LSC Site starting near Atkinson and proceeding south to State Route 248. Sampling included collecting soil samples for analysis by the State laboratory and sampling the soil in the field with the XRF (Figure 3). In addition, one opportunity surface water sample (LSC-SW-06) was collected from the unnamed spring south of the historical Big Four Mill site. A total of 229 XRF files were created, and includes four files associated with sediment sample LSC-SD-77 initially intended to be analyzed by the laboratory. Of the remaining 225 samples, 12 files were instrument calibrations and the remaining 213 files were comprised of soil analysis data.

Of the 213 samples analyzed with the XRF, data from eight samples are not considered valid due to the low analysis time (a count of less than 60, the average count was 200). Six of the eight low-count samples shared the same GPS data with another acceptable XRF sample. In addition, four

XRF samples have no GPS data, and 10 XRF samples were located within a few feet of another XRF sample and share the same GPS data. Therefore, results consist of a total of 207 valid XRF soil sample analyses with corresponding GPS data (includes 10 XRF samples that share the same GPS data as another XRF sample). All XRF analytical data are provided in Tables 1 and 2. The Field Activities report in Appendix A provides additional sampling information.

4.0 SAMPLING RESULTS

The XRF analysis results are illustrated in Figures 4 through 8 and summarized in Tables 1 and 2. Figures 9 through 12 illustrate the laboratory samples results that are summarized in Tables 3, 4 and 5. The actual Laboratory Analytical Reports are provided in Appendix D. There are 15 metals in the soil samples that were analyzed by both the XRF and State Laboratory (Tables 5 and 6). A comparison of the XRF analysis and the laboratory analysis of the soil at the same location is summarized in Table 6. The factor of error in the analysis of XRF samples compared to laboratory-analyzed samples is generally less than ten percent at low concentrations and may be more than 50 percent at high concentrations. Figures 13, 14 and 15 illustrate the approximate location of the concentration contours for lead, mercury, and zinc using the data from the soil samples analyzed by the XRF (created by the Surfer groundwater modeling computer program and ArcView computer program).

The surface water and sediment sample analytical results were compared to available benchmarks based on EPA's June 1996 Superfund Chemical Data Matrix (SCDM) with the exception of the benchmark for lead in a soil medium. A soil-lead hazard standard of 400 parts per million (ppm) for play areas (1,200 ppm in non-play areas) was used in this report based on an EPA Guidance 40 CRF Part 745, January 5, 2001. There are no benchmarks established for sediment and background samples were not collected as part of this IA.

Two discrepancies found in the State Laboratory Analysis Report pertain to samples LSC-SW-06 and LSC-SW-15. The analysis results of sample LSC-SW-06 (laboratory sample 200109921) were labeled in ppm units, and the actual units were parts per billion (ppb). The laboratory reported 10 ppb of nickel for sample LSC-SW-15 (laboratory sample 200109931). However, all of the other surface water sample results have a nickel concentration less than 10, therefore the sample location could be re-sampled to confirm the results. The sample analysis discrepancies were discussed with the laboratory and adjustments were made in summarizing the data. Some of the units of measurement of the surface water samples were received from the laboratory in ppm and converted to ppb for consistency purposes within the summarized table (Table 3).

4.1 XRF Sampling Results

The XRF instrument analyzes metals by either a calibration reference to the cadmium source (Table 1), or an americium source (Table 2). Sediment sample LSC-SD-77 and XRF soil sample 289 were analyzed using both XRF sources. The remaining XRF soil samples were analyzed with the cadmium source. The analytes of the XRF soil samples with concentrations that exceeded a hazard standard or a SCDM benchmark are lead, arsenic, mercury, zinc, manganese, chromium, antimony, and cadmium.

The XRF analysis detected lead above the detection limit at every location and nearly every location showed lead results exceeding the hazard standard of 400 ppm (Figure 4 and 13). The highest lead concentration was 37,196.8 ppm detected in XRF sample 283 collected north of Atkinson on the same mound as sample LSC-SS-78 that had a (laboratory analyzed) concentration of 36,100 ppm. The lowest lead concentration detected was 23 ppm in XRF sample 220 collected west of Silver Creek and south of sample LSC-SS-70 (Figure 3).

The XRF analysis detected elevated arsenic concentrations at nearly as many sample locations as it did elevated lead concentrations (Figure 5). The highest arsenic concentration detected was 2,160 ppm in the XRF sample 173 (soil sample LSC-SS-66, 913 ppm). The lowest arsenic concentration detected by the XRF was less than the detection limit. The error factor value for some XRF samples may have exceeded the benchmark values (notated in brown in Table 1). Also noted is the interference in the XRF analysis of arsenic and lead. In analyzing the two metals, if the XRF detects high concentrations of lead it will also detect high concentrations of arsenic, which may not accurately reflect actual arsenic concentrations. A comparison of the variance in the arsenic concentrations detected by the laboratory and XRF analyses was less than 10 percent for 7 of the 21 samples, between 10 to 50 percent for 9 of 21 samples, and between 50 to 100 percent for 5 of the 21 samples. A comparison of XRF and laboratory soil sample results is summarized in Table 6.

The majority of the XRF samples with mercury concentrations above the benchmark of 23 ppm were collected north of Homer Spring (Figure 6 and 14). Photo 4-14 in Appendix B shows the sampling area and several non-vegetated mounds. The highest mercury concentration detected by the XRF was 149 ppm (XRF 240) at a location south of sample LSC-SS-71, which had a mercury concentration of 144.2 ppm (Figure 3). The lowest mercury concentration detected by the XRF was less than the detection limit (Table 1).

The location of XRF samples with zinc concentrations that exceeded the benchmark of 23,000 ppm were primarily collected from an area containing several non-vegetated mounds near Homer Spring (Figure 7 and 15). The highest zinc concentration detected by the XRF was 96,460.8 ppm in XRF sample 172 collected northeast of sample LSC-SS-66 and XRF 173 that had zinc concentrations of 48,700 ppm and 53,860 ppm, respectively. A number of the XRF samples had zinc concentrations above the level of detection, but less than the benchmark. The lowest zinc concentration detected by the XRF was 181ppm in XRF sample 220 (collected west of Silver Creek and south of sample LSC-SS-70), which also contained the lowest lead concentration (23 ppm).

There are a total of 11 XRF soil samples with chromium concentrations exceeding the benchmark of 390 ppm (Figure 8). The highest chromium concentration detected by the XRF was 3696.6 ppm (XRF 187) in an upland area west of the Rail Trail and south of sample LSC-SS-66. Several of the soil samples analyzed by the XRF had chromium concentrations less than the detection limit.

4.2 Soil Sampling Results

A summary of the laboratory analysis of the soil samples is provided in Table 5 and illustrated in Figures 9 through 12. A comparison of the XRF and laboratory analysis of the soil samples is provided in Table 6. The laboratory results for the soil samples show metal concentrations exceeded the hazard standard or SCDM benchmark for lead, arsenic, mercury, zinc, antimony, and cadmium.

Of the 21 soil samples analyzed by the laboratory, 20 had lead concentrations exceeding 400 ppm. Sample LSC-SS-61 collected near the unnamed spring south of the historical Big Four Mill site, had a lead concentration was 8.56 ppm. The highest concentration of lead was 36,100 ppm detected in sample LSC-SS-78 collected from the mound adjacent to Silver Creek north of Atkinson. Generally, higher lead concentrations were detected in samples collected west and north of Homer Spring and concentrations were lower in samples collected immediately south of Atkinson than those collected near State Route 248. Samples LSC-SS-64 (22,300 ppm) and LSC-SS-65 (26,000 ppm) were collected immediately north and south, respectively, of the section not sampled (due to a lack of access to the property). Lower lead concentrations (1040 ppm to 3360 ppm) were detected in samples collected from the upland between Silver Creek and the Rail Trail (north and south of Promontory Road).

All 21 soil samples analyzed by the laboratory had arsenic concentrations above the SCDM benchmark of 23 ppm. The soil samples with high lead concentrations similarly have high arsenic concentrations with the exception of sample LSC-SS-61, which had a low lead concentration (8.56 ppm), but an elevated arsenic concentration (77 ppm). The highest arsenic concentration was detected in sample LSC-SS-78 at 870 ppm, and the lowest concentration was detected in sample LSC-SS-64 at 48 ppm. Sample LSS-SS-78 was collected from a mound adjacent to Silver Creek and downstream from Atkinson. Sample LSC-SS-64 was collected from the upland adjacent to the Rail Trail and south of the historical Big Four Mill site.

The location of soil samples analyzed by the laboratory with mercury concentrations exceeding SCDM (23 ppm), are provided in Figure 9. The area immediately north of Homer Spring contains five of the seven sample locations with mercury concentrations exceeding SCDM. Sample LSC-SS-61 collected from the unnamed spring south of the Big Four Mill site had a mercury concentration of 32 ppm. The highest mercury concentration of 144 ppm was detected in sample LSC-SS-71.

Eleven of 21 soil samples had zinc concentrations that exceeded SCDM (23,000 ppm), and an additional sample, LSC-SS-56, had a concentration (22,700 ppm) just under SCDM. The highest zinc concentration was detected in sample LSC-SS-65 at 60,400 ppm. The locations of the soil samples with high zinc concentrations are generally found in the riparian area (Figure 10)

Antimony concentrations exceeded the SCDM benchmark of 31 ppm in all soil samples except sample LSC-SS-64, which had a concentration of 22 ppm. The highest concentration of antimony was detected in sample LSC-SS-66 at 568 ppm (Figure 11).

Cadmium concentrations exceeded the SCDM benchmark of 39 ppm in 15 of the 21 soil samples. Elevated cadmium concentrations were generally detected in samples collected in the riparian area (Figure 12). The highest cadmium concentration of 295 ppm was detected in sample LSC-SS-65 (Figure 3).

4.3 Sediment Sampling Results

A summary of the results of the laboratory analysis of the 24 sediment samples is provided in Table 4. There are no SCDM benchmarks for sediment samples and no background samples were collected. The sediment samples and surface water samples were collected concurrently from Silver Creek and are discussed in Section 5.0 of this report (Figures 2 and 3).

All 27 sediment samples had lead concentrations above 400 ppm. The highest lead concentration detected was 13,700 ppm in sample LSC-SD-38 (SW-08) collected downstream from the historical Big Four Mill site. The most upstream sample location, sample LSC-SD-31 (SW-01), had a lead concentration of 7,650 ppm. A lead concentration of 752 ppm was detected in sample LSC-SD-76 (SW-28) collected immediately upstream from the Silver Creek and Weber River confluence.

All 27 sediment samples had arsenic concentrations above 23 ppm. The lowest arsenic concentration was detected in sample LSC-SD-50 (SW-20) at 28 ppm. The highest arsenic concentration was detected in sample LSC-SD-40 (SW-10) at 555 ppm. The arsenic concentrations in the sediment samples increased downstream from State Route 248 with sample LSC-SD-31(SW-01) at 328 ppm to 555 ppm detected in sample LSC-SD40 (SW-10) near Atkinson. Downstream from Atkinson, sample LSC-SD-41 (SW-11) had an arsenic concentration of 252 ppm and arsenic concentrations generally continued to decrease downstream to Wanship (LSC-SD-55, 38.5 ppm).

The mercury concentrations in sediment samples LSC-SD-40 (SW-10) and LSC-SD-53 (SW-23) were 33.5 ppm and 34.2 ppm, respectively. In all of the other sediment sample mercury concentrations did not exceed 11.1 ppm.

The zinc concentrations in two sediment samples were above 23,000 ppm. Samples LSC-SD-39 (SW-09) and LSC-SD-40 (SW-10) had a zinc concentration of 27,300 ppm and 30,300 ppm, respectively. A zinc concentration of 22,200 ppm was detected in sample LSC-SD-31 (SW-01) near State Route 248. The zinc concentration near the Weber River and Silver Creek confluence was 1,430 ppm in sample LSC-SD-76 (SW-28).

Antimony concentrations were above 31 ppm in 13 of the 24 sediment samples. Near State Route 248, sample LSC-SD-31 (SW-01) had an antimony concentration of 111 ppm. An elevated antimony concentration of 338 ppm (LSC-SD-40, SW-10) was detected in a sample collected from the center of the southern portion of the LSC Site. The downstream antimony sediment concentration dropped off to less than 12 ppm with sample LSC-SD-46 (SW-16) located 3 miles downstream from Atkinson.

Cadmium concentrations were above 39 ppm in 12 of 24 sediment samples. Sample LSC-SD-31 (SW-01) collected near State Route 248 had a cadmium concentration of 122 ppm. Downstream from State Route 248 the concentrations dipped and then rose to 145 ppm with sample LSC-SD-40 (SW-10), and then dropped to 11.4 ppm in sample LSC-SD-46 (SW-16). In addition, an elevated cadmium concentration of 64.4 ppm was detected in sample LSC-SD-55 (SW-25) collected in Wanship.

4.4 Surface Water Sampling Results

Surface water samples and sediment samples were collected concurrently from Silver Creek and analyzed by the State Laboratory. A summary of the results of the laboratory analysis of the 27 surface water samples is provided in Table 3. Surface water sample locations are shown in Figures 1 and 2. Surface water samples had lead, antimony, and cadmium concentrations that exceeded the SCDM maximum contaminate level (MCL) for drinking water. In addition, lead, mercury, zinc, copper, chromium, and cadmium concentrations exceeded the SCDM environmental freshwater benchmark for the acute and chronic ambient water quality criteria (AWQC) and the acute and chronic aquatic life advisory concentrations (AALAC).

Twenty-three of the 27 surface water samples had lead concentrations exceeding the drinking water benchmark of 15 ppb. Generally, the surface water lead concentrations detected in the Silver Creek samples decreased downstream from sample LSC-SW-10 with a high of 260 ppm collected near the old school house to sample LSC-SW-28 with 15 ppb collected upstream of the Weber River confluence. The three samples collected between Homer Spring and State Route 248 detected lead concentrations that increased downstream from 18 ppb to 33 ppb. Samples with lead concentrations below the drinking water benchmark are sample LSC-SW-29 (Alexander Canyon Creek), sample LSC-SW-06 (the unnamed spring south of the Big Four Mill site), and sample LSC-SW-08 and LSC-SW-09 (collected upstream from the water treatment facility). Twenty-five surface water samples exceeded the environmental freshwater benchmark for lead.

All samples had zinc concentrations that exceeded the environmental freshwater benchmark of 110 ppb (there is no drinking water benchmark for zinc). Mercury concentrations were less than the drinking water benchmark of 2 ppb, however, the limit of detection (0.2 ppb) was greater than the freshwater benchmark of 0.012 ppb. Copper concentrations were less than the benchmarks except for sample LSC-SW-10 (26.4 ppb), which exceeded the environmental freshwater benchmark of 12 ppb. Chromium concentrations were less that the benchmarks except for sample LSC-SW-15 (18.8 ppb), which exceeded the environmental freshwater benchmark of 11 ppb. The thallium drinking water benchmark (0.5 ppb) was less than the limit of detection (1 ppb).

Antimony concentrations exceeded the drinking water benchmark of 6 ppb in 25 of the 27 surface water samples. The antimony concentrations decreased downstream from a high of 37 ppb in sample LSC-SW-07 collected south of the Summit County Sheriff's facilities to 14.7 ppb in sample LSC-SW-28 collected above the confluence with the Weber River. Antimony concentrations of less than 3 ppb were detected in samples LSC-SW-06 (unnamed spring south of historical Big Four Mill site) and LSC-SW-29 (Alexander Canyon). The three samples collected between Homer Spring and State Route 248 had antimony concentrations between 7.7 ppb to 7.2 ppb.

The cadmium concentration in all the surface water samples exceeded the environmental freshwater benchmark of 1.1 ppb. Cadmium concentrations exceeded drinking water benchmark of 5 ppb in three samples (LSC-SW-07/08/09) and nearly so in a fourth sample (LSC-SW-10). The highest cadmium concentration detected was 7 ppb in sample LSC-SW-08. The locations of the samples with high cadmium concentrations are between a point immediately upstream from the unnamed spring (near the Big Four Mill site) and Atkinson.

5.0 SUMMARY AND CONCLUSIONS

The headwaters of the Silver Creek Watershed are in the mountains above Park City. The LSC Site encompasses the lower reaches of Silver Creek and the surrounding riparian habitat as the creek meanders more than 12 miles between State Route 248 and the confluence with the Weber River in Wanship. The DWQ has monitored Silver Creek for the last 10 years and has listed Silver Creek on the State of Utah's 303(d) list as impaired by zinc and cadmium. Apparent mine tailings had previously been observed within the LSC Site. The DERR has investigated this site to assess possible contamination resulting from historical mining operations in the area. There are several upstream pre-CERCLIS and CERCLIS-listed sites either previously or currently under investigation.

Mining in the Park City area began around 1869 and the first shipment of ore, 40 tons, was sent out by rail in July 1870. The total production of ore from the mining area for the years 1875 to 1967 was nearly 16 million tons. There have been as many as 10 mills operating along the banks of Silver Creek throughout the history of mining near Park City. The majority of milling companies along Silver Creek were located upstream of LSC. Historically, the primary mill operating within the LSC Site was the Big Four Mill. The footings of the foundation of the Big Four Mill are located next to Pace Ranch building adjacent to the road between the Summit County Sheriff's facility and the Pivotal Promontory, LLC development project (Promontory Road) (Photo 3-17, Appendix B).

In 1916, the Big Four Mill was said to be the third largest mill in the state, consisting of a two-month stockpile of 50,000 tons of ore and the capacity to process 1,800 tons of ore tailings daily. The tailings field at the Big Four Mill site was 3.5 miles by 400 to 1200 feet wide and two inches to eight feet deep. The settling pond for the Big Four Mill held 200,000 gallons and was 100 feet in diameter by four feet deep[1]. By 1918, Big Four had over-sold company stock and the mill was sold in bankruptcy proceedings for $35,500[1]. After its closure, the mill site was still considered to be worth milling[1]. In the mid 1900's additional mill related activities on the LSC Site included removing mine tailings off-site for processing[4,5,6]. The creation of mounds and berms on-site may have been part of the preparations to remove tailing from the site for processing. In the 1940's, Silver Creek reportedly flowed milky-white as a result of tailings in the area (see Photos 3-1 and 3-4)[4].

Most of the property within the LSC Site is privately owned and fenced (for cattle) along the Rail Trail. In 1992 and 1993, the Rail Trail was constructed on the historical Union Pacific Rail Road and is under the direction of the Utah Division of Parks and Recreation. The Rail Trail starts in Park City, crosses over State Route 248 and continues north throughout the length of the LSC Site downstream to Wanship and beyond. The Rail Trail is open to the public, and is used frequently as a non-motorized pathway for recreational purposes including hiking, bicycling, observing wildlife, and access to fishing Silver Creek north of Atkinson. The Rail Trail was not extensively sampled within this study and may warrant further sampling (Photo 3-5, XRF 79 in Table 1).

The site has been subdivided into southern and northern portions, due to the site conditions and topography. Mine tailings generally cover the entire southern portion of the LSC Site (State Route 248 to Atkinson). Tailings are readily apparent in the non-vegetated, gray colored sandy or gravelly mounds and low ridges (or berms) within the riparian habitat along Silver Creek (Appendix B, Log of Photographs). The vegetation in the southern portion of the LSC Site (upstream from Atkinson) vegetation primarily consists of a sedge grass (locally referred to as "wire-grass") that is not palatable to the livestock (primarily cattle) and is rarely eaten by them. The northern portion of the LSC Site area is generally a well-vegetated riparian habitat. Mine tailings were not observed more than a mile downstream from Atkinson during field activities.

Sampling activities occurred on eight days in November 2002. Sampling included a total of 207 valid XRF soil samples and the concurrent collection of 21 soil samples (approximately 10 percent of the XRF samples) for laboratory analysis. A total of 22 surface water and sediment samples were collected concurrently from Silver Creek within a 7.5-hour period. In addition, flow measurements of Silver Creek were taken (Appendix E), and opportunity samples of the surface water and sediment were collected.

The concentration of metals in the soil samples detected by the XRF were similar to the results of the laboratory analysis with consideration of the factor of error and variance associated with XRF analyses of high concentrations. The majority of soil and XRF samples with elevated concentrations of metals were collected from the area west of Homer Spring and north through the center of the site to an area west of the old school house site (Figure 3).

The surface water samples exceeded SCDM drinking water benchmarks (MCL) for lead, antimony, and cadmium. In both the sediment and surface water samples, similarly elevated concentrations of lead, antimony, and cadmium were detected. The sediment and surface water sample concentrations were generally highest in samples collected west of the old school house and higher in samples collected near State Route 248 than those collected near Wanship. Fish were observed in Silver Creek upstream from Wanship up to the reach adjacent to the old school house (Figure 3), which is the area with the highest metal concentrations detected in the sediment samples and surface water samples.

The primary targets of concern are the persons using the Rail Trail and fishing in Silver Creek. The site does not contain residences, however, a high-end residential development (Promontory project) to the east is currently being developed and commercial and government facilities are located to the west of the site. Other important issues related to this site include the environmental impacts of heavy metal in the ecological system, specifically, the water quality of Silver Creek and the migration of contaminates to the Weber River. Therefore, the primary contamination pathways of concern are the surface water and contact with the soil either directly or by entrainment. The groundwater pathway may be of concern by association with the wetlands through the recharge/discharge cycle. At the time of this report, there are four municipal wells within the site serving a combined population of 950 persons.

The completed "Pre-CERCLIS Screening Assessment Checklist/Decision Form" is enclosed in this report as Appendix E. This checklist concludes with the recommendation that the LSC Site should be entered into CERCLIS, and further assessment under CERCLA is recommended based on the analytical results of samples collected on the site.

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